

(21) Application No 8720745.2

(22) Date of filing 03.09.1987

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(51) INT CL⁴
H02K 23/00

(52) UK CL (Edition J)
H2A ARE
U1S S2109

(56) Documents cited
GB 1299057 A

(58) Field of search
UK CL (Edition J) H2A ARE ARJ
INT CL⁴ H02K

(54) A permanent magnet d.c. electric motor

(57) A permanent magnet direct current electric motor comprises a motor frame 10, 11, 12, brushgear 32 and one or more permanent magnets 15 supported by the frame, and an armature 19 of disc form supported for rotation in the frame. The permanent magnet(s) define a four pole magnetic field and the armature comprises six winding coils 22 regularly spaced around the circumference of the armature, diametrically opposite coils being connected electrically in series or parallel with one another. Preferably, connections between a commutator 23 and the winding coils are printed on a film 24 secured to the armature. The commutator may also be printed on the film.

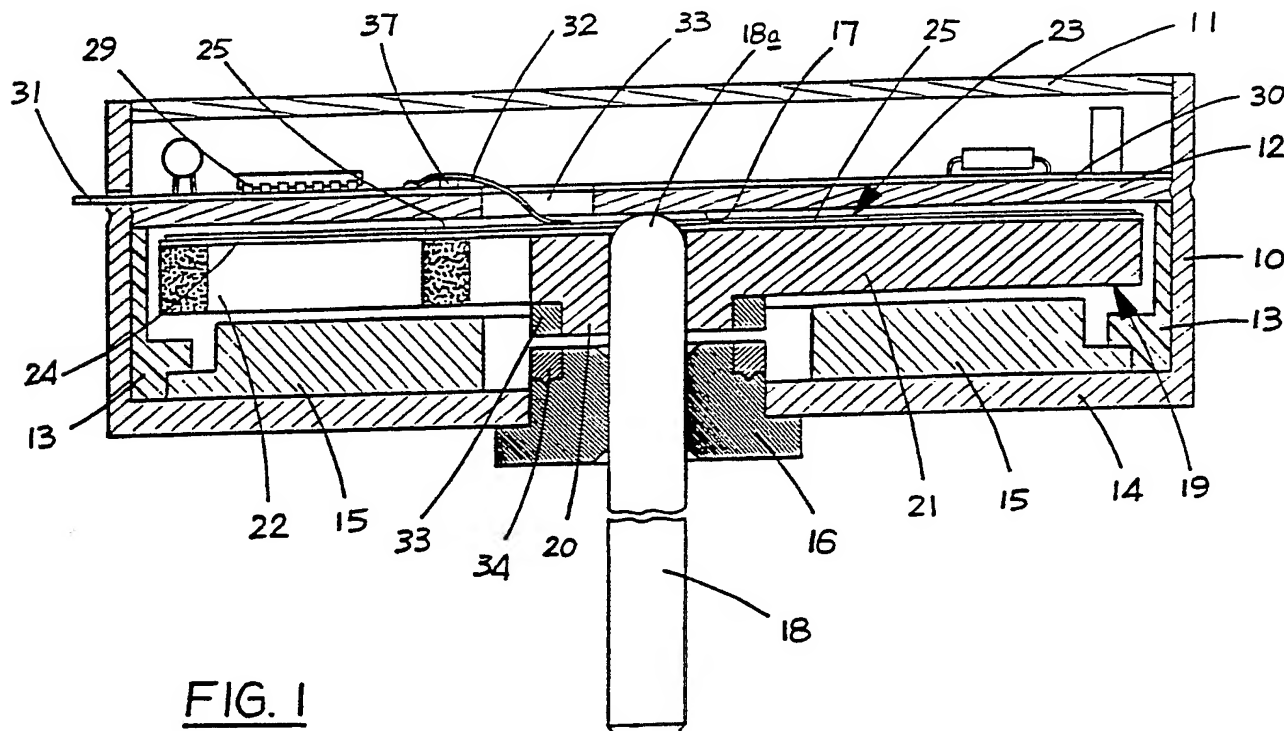


FIG. 1

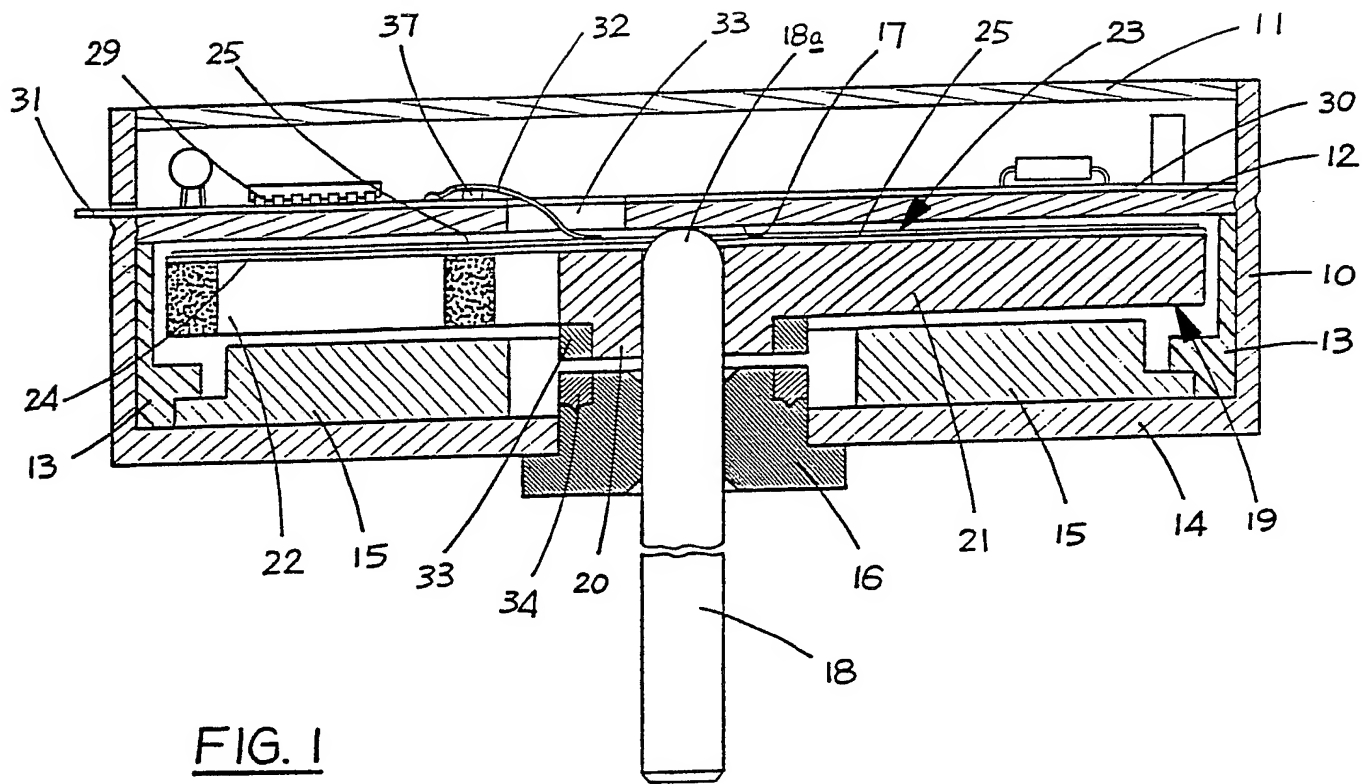


FIG. 1

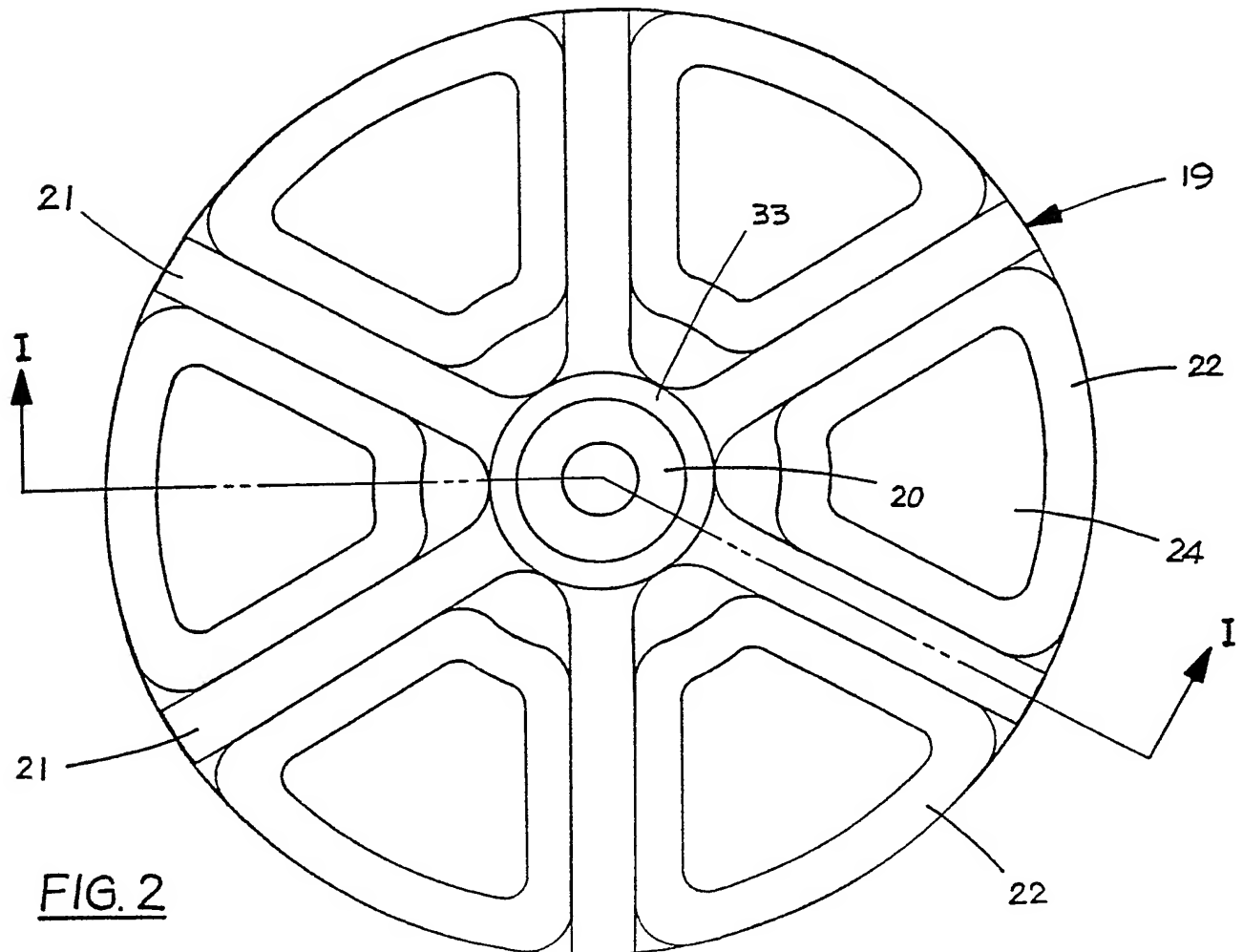
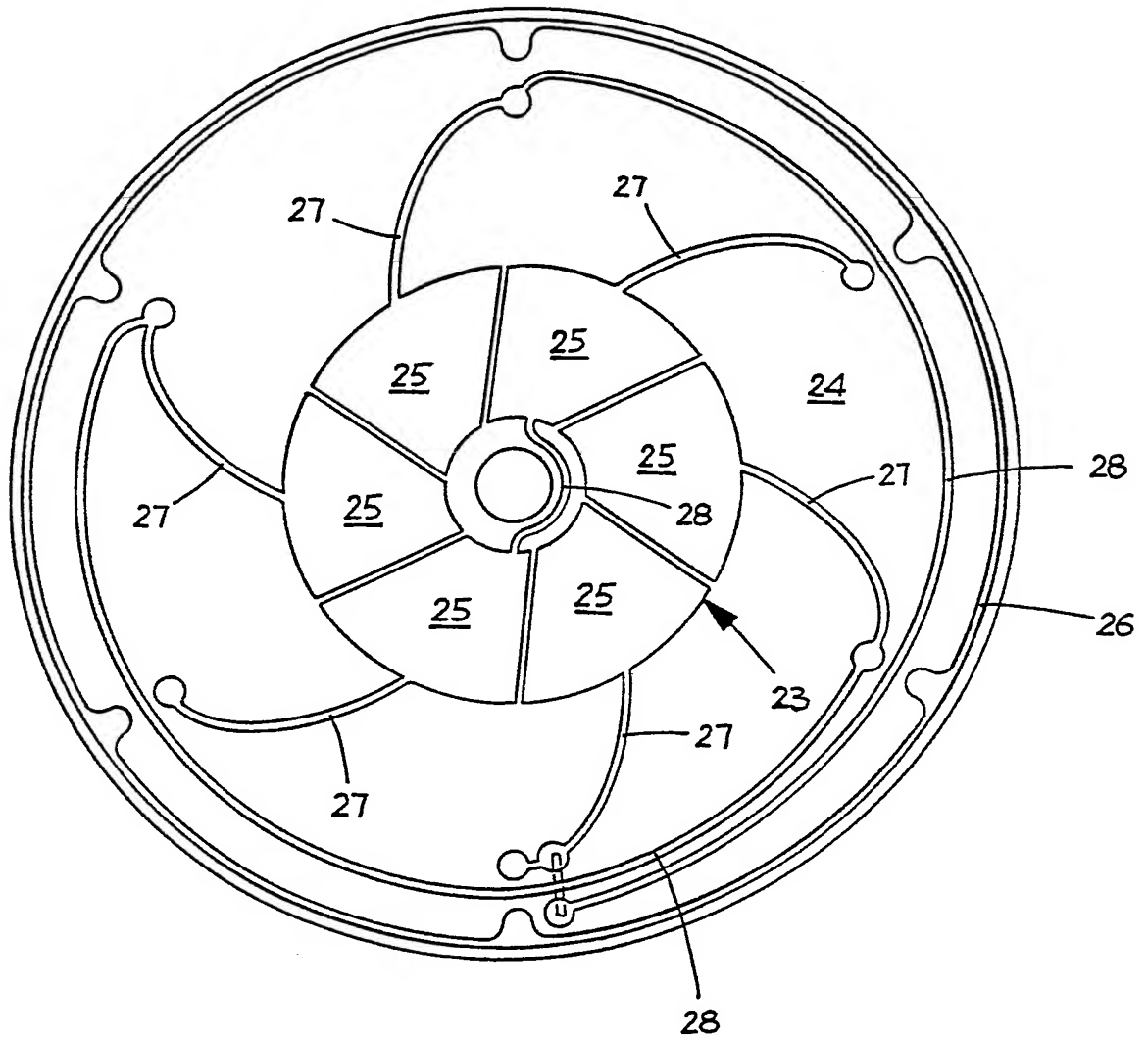
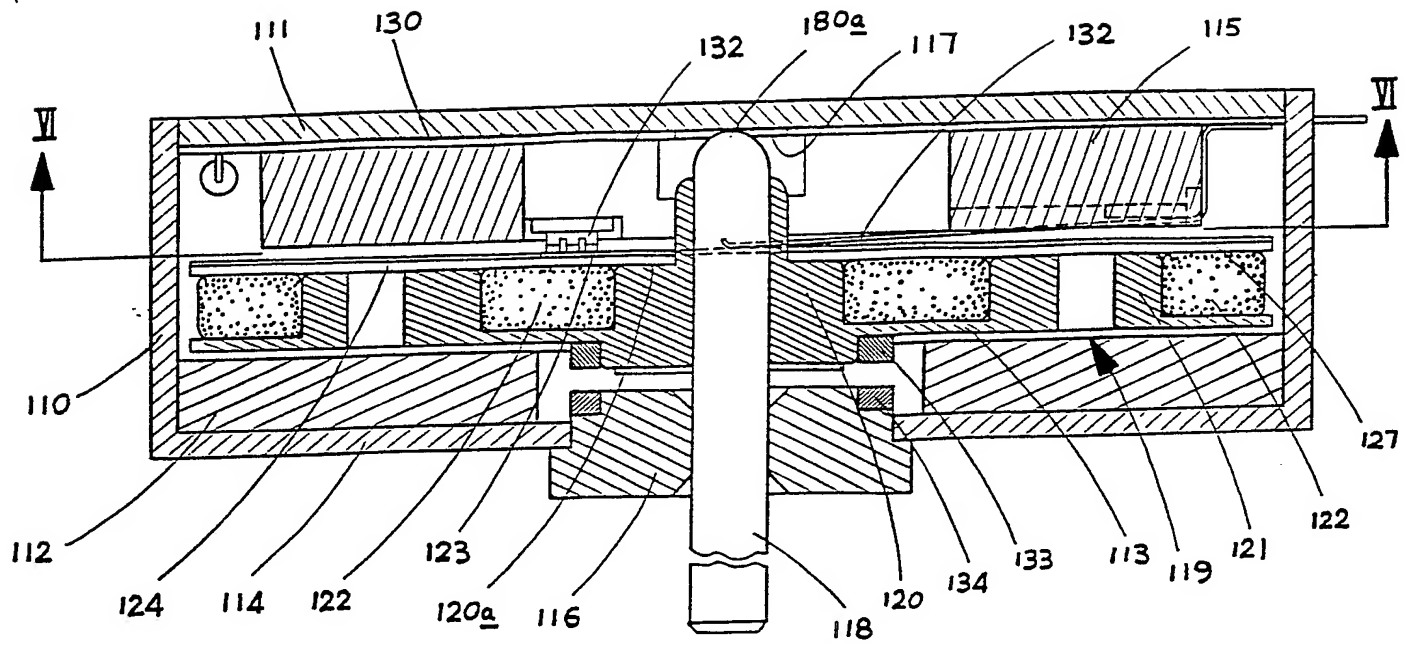
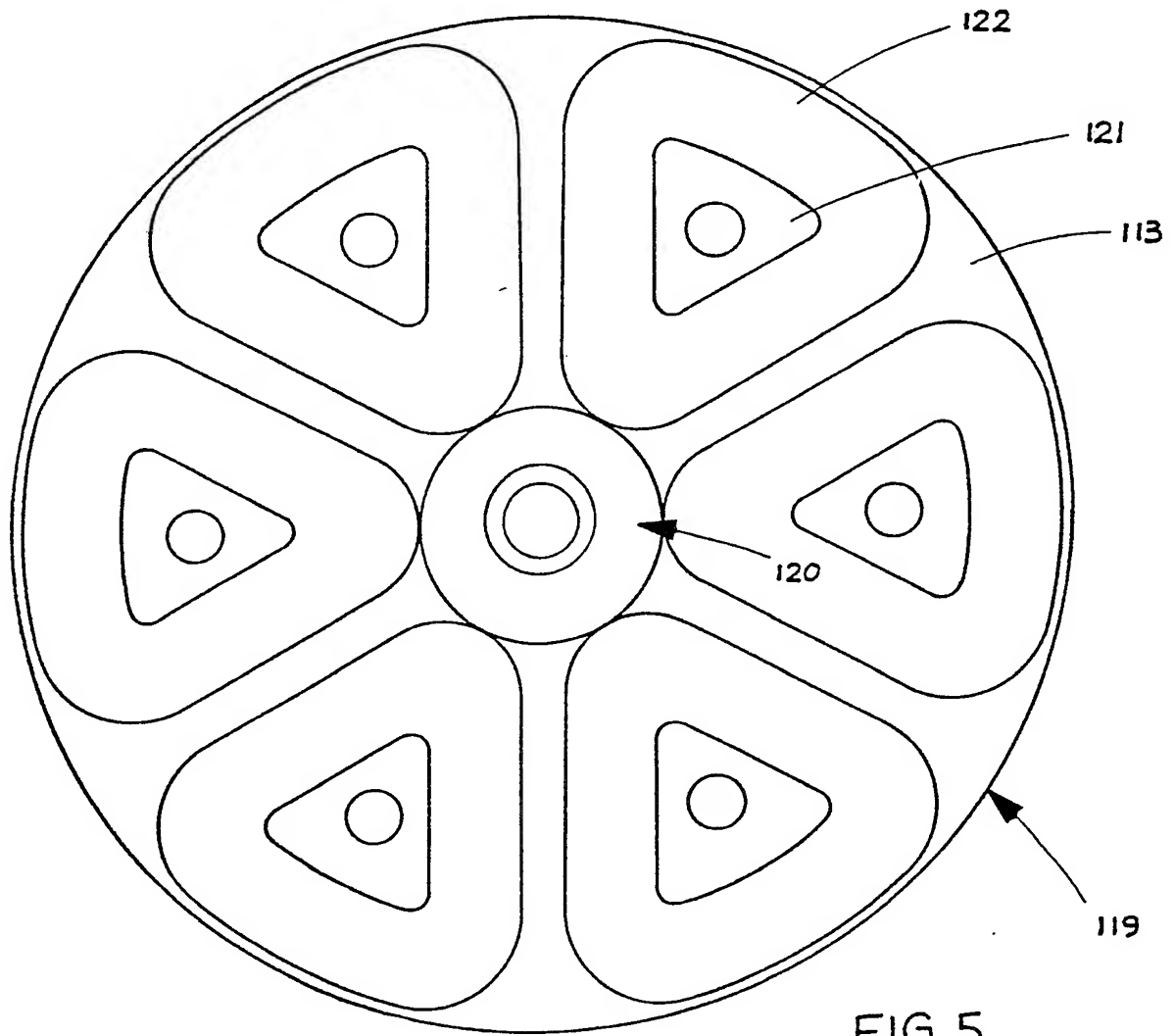
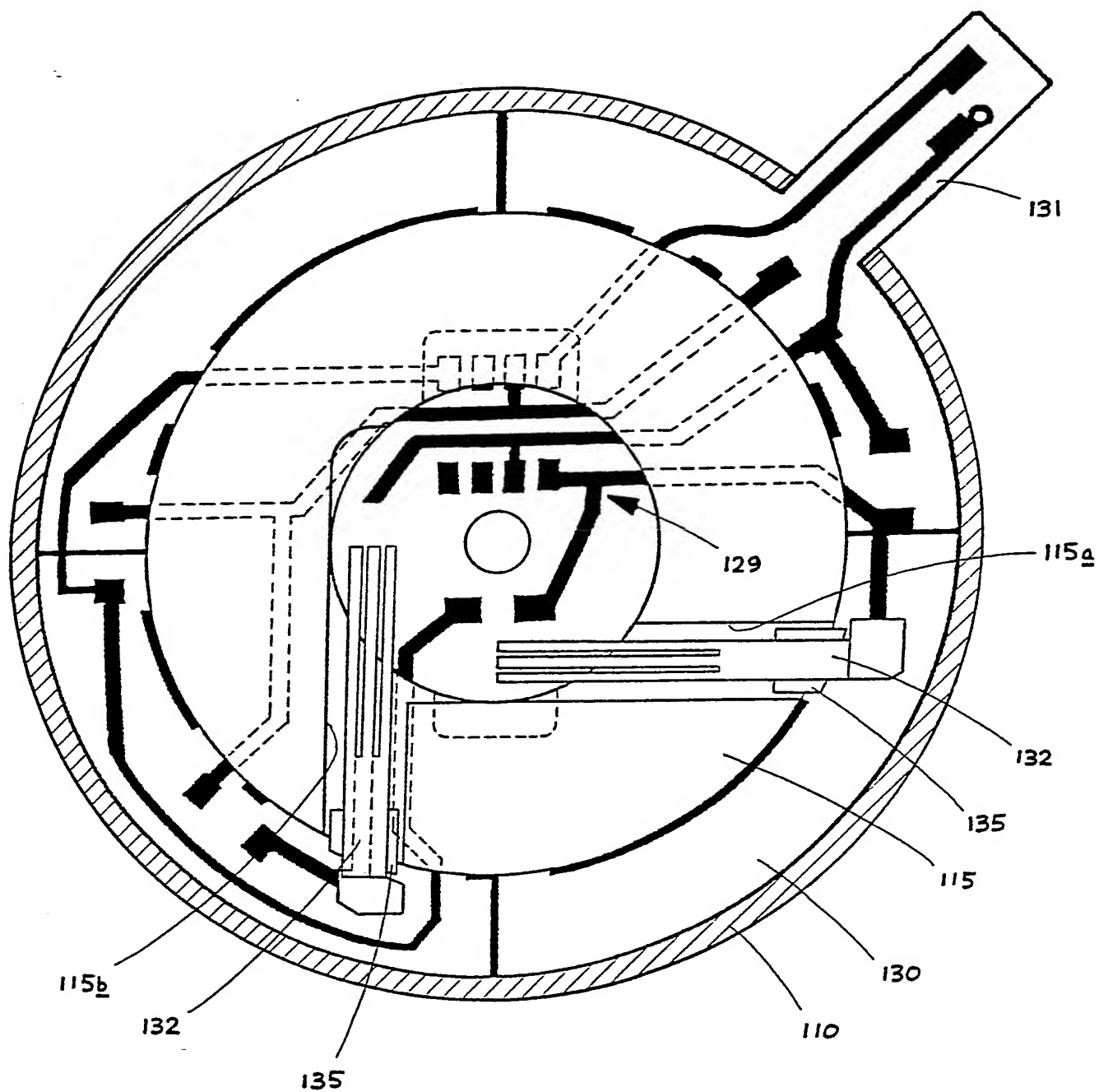


FIG. 2

FIG. 3

FIG. 4FIG. 5

FIG. 6

AN ELECTRIC MOTOR

This invention relates to a permanent magnet direct current electric motor and in particular to a fractional horsepower p.m.d.c. motor, such as may be
5 used to drive audio equipment.

It is known in instruments and very small p.m.d.c. motors to use moving coil motors in which the coils are suspended in air in the gap between magnets and return paths. In a disc type moving coil motor it
10 is common to provide three coils in a two pole magnet system, each coil being energised at the appropriate time and with the right polarity to create a continuity of torque produced.

However in a disc type moving coil motor the
15 effective parts of the winding are those sections of the winding wire which run in and out as radials and which therefore cut flux at the appropriate angle. Thus if a coil spans 120 degrees of arc the larger part of the winding wire is run circumferentially
20 and creates resistance without producing torque. Furthermore the ripples in the torque developed are large enough to cause some disturbance in the stability of the motor's velocity.

According to the invention there is provided a permanent magnet direct current electric motor comprising a motor frame, brushgear and permanent magnet means supported by the motor frame, and an
5 armature of disc form, having a commutator, supported for rotation in the motor frame, wherein the permanent magnet means defines a four pole magnetic field and wherein the armature comprises six winding coils regularly spaced circumferentially
10 around the armature, diametrically opposite coils being connected electrically in series or parallel with one another.

Preferably, the armature includes a six bar commutator in which diametrically opposite bars are
15 electrically interconnected and the brushgear comprises two brushes which make contact with the commutator at positions which are spaced apart by 90 degrees.

In such an arrangement the ratio of useful to
20 useless wire length is greatly improved and the time constant of the ripple is reduced thus damping down its effect on constant velocity.

If the flux density around the four pole system can be made near trapezoidal in value then the winding coils can be connected to form a parallel star winding system with each coil being open circuited
5 for a period as it passes across a pole face and experiences no change in flux energy.

If the flux density across each pole face is sinusoidal then the winding coils can be connected to form a parallel pair of delta windings so that
10 each coil plays a continuous part in developing torque.

Preferably, the connections between the commutator and the winding coils are printed on a film secured to the armature. The film may be self adhesive.

15 Advantageously, the commutator is also printed on the film.

The invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a sectional view of one embodiment of an electric motor according to the present invention, the section through the armature being taken along line I-I of Figure 2.

5 Figure 2 is an underneath plan view of the armature of Figure 1,

Figure 3 is a top plan view of the armature of Figure 1,

Figure 4 is a sectional view of another embodiment
10 of an electric motor according to the invention,

Figure 5 is a top plan view of the armature of Figure 4 with the film bearing the commutator omitted, and

Figure 6 is a section taken along line VI-VI of
15 Figure 4, with the electronics components omitted from the printed circuit film.

Referring first to Figures 1 to 3 of the drawings, the motor shown therein has a motor frame comprising a drawn shallow metal can 10 closed by a metal end
20 cap 11.

A plate 12 is provided within the can 10 and forms part of the motor frame. The plate 12 is located axially against a plastics sleeve 13 disposed within the can 10 and the plate 12 is secured in position by
5 dimpling the can from the outside to pinch and thus secure the plate 12 in position.

The inner surface of the base 14 of the can 10 supports four segmental permanent magnets 15. The magnets 15 are glued to the base 14 and adjacent
10 magnets are magnetised in opposite axial directions. The magnets 15 are stepped at their outer circumferentially extending edges and these stepped edges are engaged by an annular, stepped, radially inwardly extending portion of the sleeve 13 to
15 provide additional support for the magnets. The magnets could be replaced by a single annulus appropriately magnetised.

A radial bearing 16 is fixed in the base 14 of the can 10 and a thrust face 17 is provided on the inside
20 of the plate 12.

A motor armature comprises a shaft 18 which is journalled in the radial bearing 16 and which has a part spherical non-driving end 18a bearing against the thrust face 17. The armature also comprises a plastics winding support 19 mounted fast on the shaft 18. The support 19 comprises a hub 20 and six radially extending spokes 21. Six discrete winding coils 22 are fixed between the spokes 21 of the support 19, such as by glue, and are equi-angularly spaced apart.

The hub 20 of the winding support 19 also defines a base for a commutator, conveniently a face plate commutator 23. The commutator 23 and the connections between the commutator 23 and the winding coils 22 are printed on a film 24 which is secured to the winding support 19, such as by glue. The film 24 is, conveniently, an epoxy resin or polyester based film clad with copper, etched, and subsequently masked in areas to which connections are not made. The commutator comprises six segments 25 arranged in a common plane and if desired these segments may be plated with noble metal. Typically, this would be achieved by plating the copper with nickel and then plating the nickel with noble metal. One end of each

winding 22 is connected to a star point provided by
conducting track 26 and the other end of each winding
22 is connected to a respective commutator segment 25
by respective conducting tracks 27. Diametrically
5 opposed commutator segments 25 are electrically
connected together by respective conducting tracks 28.

A speed regulating circuit 29 provided on a printed
circuit film 30 is attached to the outer surface of
10 the plate 12. Electrical terminations of the motor
are printed on a tab 31 integral with the film 30 and
are led out of the can 10 through an opening in the
side wall thereof.

Two resilient precious metal brush leaves 32 forming
15 brush gear of the motor are soldered directly to the
printed circuit film 30 and extend through holes 33
in the plate 12. The free end of each brush leaf 32
is forked and these ends of the brush leaves define
brushes proper which make contact with the commutator
20 at positions which are spaced apart geometrically by
90 degrees and, as considered electrically, at
positions appropriate for optimum commutation. A
small elastomeric pad 37 is interposed between each
leaf 32 and the film 30 at a position close to the
25 soldered connection to dampen vibration.

As described above the winding coils 22 are connected in parallel star configuration. The winding coils may, however, be connected in series star configuration. In this latter case, diametrically
5 opposite winding coils are connected electrically in series and each series connected pair of coils is connected at one end to a star point and at the other end to a commutator bar, diametrically opposite commutator bars being electrically interconnected.

10 With a star system as described above, each winding coil is open circuited for a period as it passes across a pole face and during this period experiences no change in flux energy. This is particularly advantageous if the flux density across the pole face
15 is substantially trapezoidal, which is likely if high energy magnets, such as neodymium iron boron magnets, are used.

In contrast, if the magnets are of a low energy content then the flux density across the pole faces
20 will be sinusoidal and in that case it may be advantageous to connect the windings to form a parallel pair of delta windings so that each coil plays a continuous part in developing torque. In

this latter case, diametrically opposite winding coils are connected electrically in parallel and between a pair of commutator bars, which are spaced apart geometrically by 120° , diametrically opposite
5 commutator bars being electrically interconnected.

Alternatively, diametrically opposite winding coils may be connected in series and each series connected pair of coils may be connected between a pair of commutator bars, which are spaced apart by 120°
10 geometrically, diametrically opposite commutator bars being electrically interconnected.

Coaxial ring magnets 33 and 34 are fitted on the hub 20 and on the radial bearing 16, respectively. The magnets 33 and 34 have their magnetic fields axially
15 oriented with like poles adjacent so that the repulsion forces between the magnets urge the shaft 18 into contact with the thrust face 17.

The end cap 11 is secured to the can 10 by splayed lugs on the end cap 11 engaged in notches in the end
20 of the can 10.

Referring now to Figures 4 to 6, the motor shown therein has a motor frame comprising a drawn shallow metal can 110 closed by a metal cover plate 111.

5 A mild steel keeper ring 112 is glued to the base 114 of the can 110.

A radial bearing 116 is fixed in the base 114 and a thrust face 117 is provided on the inside of the cover plate 111.

10 A motor armature comprises a shaft 118 which is journalled in the radial bearing 116 and which has a part spherical non-driving end 118a bearing against the thrust face 117. The armature also comprises a plastics winding support 119 mounted fast on the shaft 118. The support 119 comprises a hub 120, a
15 thin annular base 113 and six triangular, equi-angularly spaced bosses 121 upstanding from the base 113. Six discrete winding coils 122 are fixed about respective bosses 121, such as by glue.

20 A film 124, substantially identical to film 24 (Figure 3), has a face plate commutator 123 and connections 127 between the winding coils 122 printed

thereon. The film 124, which may be self adhesive, is secured to the upper surface of each boss 121 and to a shoulder 120a provided on the hub 120 of the winding support 119. Connections between the winding
5 coils 122 and the segments of the commutator 123 are the same as described previously in connection with the embodiment shown in Figures 1 to 3, although any of the alternative winding configurations mentioned previously could also be employed.

10 A speed regulating circuit 129 provided on a printed circuit film 130 is attached to the inner surface of the cover plate 111. Electrical terminations of the motor are printed on a tab 131 integral with the film 130 and are led out of an opening in the side wall
15 thereof or through the cover plate 111.

An annular magnet 115 appropriately magnetised to define a four pole magnetic field is secured to the printed circuit film 130, which may be self adhesive.

Cut outs 115a and 115b are provided in the side of
20 the magnet 115 remote from the film 130 in order to accommodate two resilient precious metal brush leaves 132 which are soldered directly to the printed

circuit film 130. The free end of each brush leaf 132 is forked and these ends of the brush leaves define brushes proper which make contact with the commutator at positions which are spaced apart
5 geometrically by 90 degrees and, as considered electrically, at positions appropriate for optimum commutation. A small elastomeric pad may be interposed between each leaf 132 and the magnet 115 at a position close to the soldered connection to
10 dampen vibration.

Coaxial ring magnets 133 and 134 are fitted on the hub 120 and on the radial bearing 116, respectively. The magnets have their magnetic fields axially oriented with like poles adjacent so that the
15 repulsion forces between the magnets urge the shaft 118 into contact with the thrust face 117.

The above embodiments are given by way of example only and various modifications will be apparent to persons skilled in the art without departing from the
20 scope of the invention defined by the appended claims.

Claims

1. A permanent magnet direct current electric motor comprising a motor frame, brushgear and permanent magnet means supported by the motor frame, and an armature of disc form supported for rotation in the motor frame, wherein the permanent magnet means defines a four pole magnetic field and wherein the armature comprises six winding coils regularly spaced circumferentially around the armature, diametrically opposite coils being connected electrically in series or parallel with one another.

2. An electric motor as claimed in claim 1, wherein the armature includes a six bar commutator in which diametrically opposite bars are electrically interconnected and wherein the brushgear comprises two brushes which make contact with the commutator at positions which are spaced apart by 90 degrees.

3. An electric motor as claimed in claim 2, wherein each winding coil is connected at one end to a star point and at the other end to a respective commutator bar.

4. An electric motor as claimed in claim 2,
wherein diametrically opposite winding coils are
connected electrically in series and each series
connected pair of coils is connected at one end to a
5 star point and at the other end to a commutator bar.

5. An electric motor as claimed in claim 2,
wherein diametrically opposite winding coils are
connected electrically in parallel and between a
pair of commutator bars.

10 6. An electric motor as claimed in claim 2,
wherein diametrically opposite winding coils are
connected electrically in series and each series
connected pair of coils is connected between a pair
of commutator bars.

15 7. An electric motor as claimed in any one of the
preceding claims, wherein the winding coils are
supported by a plastics winding support.

8. An electric motor as claimed in any one of the
preceding claims, wherein the connections between a
20 commutator of the motor and the winding coils are
printed on a film secured to the armature.

9. An electric motor as claimed in claim 8, wherein the commutator is printed on the film.

10. An electric motor as claimed in claim 8 or claim 9, wherein the film is self adhesive.

5 11. A permanent magnet direct current electric motor substantially as hereinbefore described with reference to the accompanying drawings.

PUB-NO: GB002209439A
DOCUMENT-IDENTIFIER: GB 2209439 A
TITLE: A permanent magnet d.c. electric motor
PUBN-DATE: May 10, 1989

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APPL-NO: GB08720745
APPL-DATE: September 3, 1987

PRIORITY-DATA: GB08720745A (September 3, 1987)

INT-CL (IPC): H02K023/00

EUR-CL (EPC): H02K023/04 , H02K023/26 , H02K023/54 ,
H02K013/04

US-CL-CURRENT: 310/177

ABSTRACT:

CHG DATE=19990617 STATUS=O> A permanent magnet direct current electric motor comprises a motor frame 10, 11, 12 brushgear 32 and one or more permanent magnets 15 supported by the frame, and an armature 19

of disc form supported for rotation in the frame. The permanent magnet(s) define a four pole magnetic field and the armature comprises six winding coils 22 regularly spaced around the circumference of the armature, diametrically opposite coils being connected electrically in series or parallel with one another. Preferably, connections between a commutator 23 and the winding coils are printed on a film 24 secured to the armature. The commutator may also be printed on the film. 